Japanese L2 Production of English Homorganic G-V Sequences: A Preliminary Study*

日本語話者による半母音-母音(G-V)連続の発音の考察：/w-u/連続のケース・スタディ

Tomomasa Sasa　（高等教育推進センター）

Abstract

日本語では、音韻制約として[w-u]のような同じ[backness]と[height]を共有する半母音-母音(G(lide)-V(owel))の連続は許容されていない。本稿では、母語にこのような音韻制約をもつ英語学習者が、英語の[w-u]の連続をどのように発音するのかを、まず観察する。3 名の日本語話者の発話を解析した結果、イ）半母音の脱落、ロ）半母音の声門化(glottalization)のいずれかを用いて、母語では許容されない G-V の連続を回避していることがわかった。後半では、最適性理論(Prince and Smolensky 1993, McCarthy and Prince 1995)を用いて、上述イ）、ロ）の状態の学習者が、これまでに習得した英語の音韻知識について、Kang (2014)の方法を用い、その特徴を論ずる。

Keywords: Second Language Acquisition, L2 Phonology, Glides, Optimality Theory

1. Introduction

It is well known that Japanese does not allow sequences of homorganic glides and vowels (e.g. **[wu]*, **[ji]*). English, on the other hand, tolerates such sequences, and as seen in (1), a wider range of Glide-Vowel sequences (henceforth G-V sequence) are attested.

(1) Examples of GV Sequences in English (Kang 2014)

a) 'weed' [wid]	b) 'win' [wɪn]	c) 'wane' [weɪn]
d) 'wed' [wɛd]	e) 'wound' [wund]	f) 'would' [wʊd]
g) won't [woʊnt]	h) 'war' [wɔr]	i) 'wand' [wænd]

In (1), English examples of G-V sequences with the preceding glide [w] are presented; as can be seen in (1), vowels of any height and backness can follow the glide [w] in English. In Japanese, on the other hand, only the [+low, +back] vowel [a] can follow [w]. These facts lead us to ask one question: "Can a Japanese speaker learning English produce a G-V sequence that does not appear in Japanese?"

The main purpose of this study is to analyze data of Japanese speakers producing English G-V sequences that are not attested in Japanese; more specifically, results of the recording of the English word *'wood'* (phonetically, [wʊd]) are discussed in this article. Throughout this paper, I will address the following three questions, and explore the answers to these questions. i) Can Japanese L2 English learners produce an English G-V sequence in which [w] is followed by [u] (or [ʊ]) (In this article, such a sequence is referred to as GV[ho] (a homorganic Glide-Vowel sequence.))? ii) If they fail to produce a GV[ho] sequence, what is the 'repair strategy'? iii) Is it possible to characterize the 'interlanguage stage' (cf. Eckman 2015) of these speakers/learners using Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1995)?

The organization of the paper is as follows; in Section 2, I present the recording procedure and

sample measurements. In Section 3, I discuss the results of the experiment. In Section 4, I present the preliminary OT analyses of the data, following Kang (2014), who discusses a similar study with Korean speakers.

2. Procedure

2.1. Participants and Procedure

For the data collection, three (3) students at Iwate Prefectural University participated in the study; two female participants (identified as f1 and f2) and one male participant (identified as m1) were asked to read eight (8) English sentences. The participants are all first year students at the university and are all taking the required first-year English courses at the university. For the comparison between participants' L2 English production and L1 Japanese production, five (5) Japanese sentences (containing an initial G-V sequence) were also recorded. However, in this article, only the results of their L2 English production are discussed (Japanese recordings are for the future research).

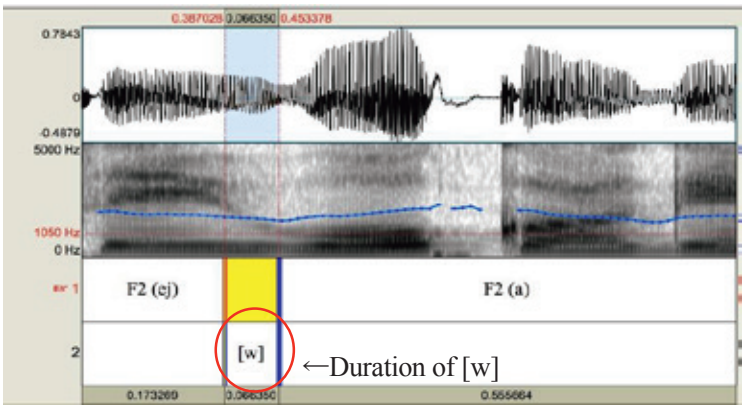
Participants were asked to read the sentences containing the target word; the target word was embedded in a carrier sentence, *"Say X (target word) again,'* and each participant read the sentence once. The recording was conducted in the author's office with a Yeti microphone. Sound files were created with free software, *Audacity*, and the measurements and analyses were conducted with free speech analysis software, *Praat*.

For this study, mainly, the recording of the word, *'wood'* ([wʊd]) is measured and discussed. As we can see, in this word, the G-V sequence of interest is observed; the [+high, +back] glide [w] is followed by a homorganic [+high, +back] vowel, [ʊ]. As discussed in Section 1, this sequence is not prohibited in English, while in Japanese, this GV[ho] sequence is never observed.

2.2. Identifying the Glide Segment

(2) shows the sample measurement criteria employed in this study; in (2), the target word is embedded in a carrier sentence, *"Say 'walk' again,"* and thus, the vowel preceding [w] is [eɪ], and the following vowel is [ɔ] in *'walk.'*

(2) Sample Measurement (*'walk'* by f2)



↑ ↑
End of stable F2 of the preceding V
Beginning of stable F2 of the following vowel

For this preliminary study, I took the portion/duration of the glide as the interval between the end

point of the preceding vowel and the beginning of the following vowel. Following Jessen (1998), I recorded the beginning of the stable portion of F2 of the following vowels as the beginning of the following vowel; likewise, the end point of the stable F2 is taken as the end of the duration of the preceding vowel.

In (2), the end of F2 of the preceding vowel, [eɪ], and the beginning of the following vowel, [ɔ] (*'walk'* [wɔk]), is labelled; the interval between these two points is taken to be the duration of the glide [w].In (2), a sudden or sharp drop of one of the formants is observed for the glide portion; as discussed in previous phonetics literature, including Ladefoged (2006), "formant structure similar to vowels, usually changing (Ledefoged 2006:197)" is an acoustic characteristic of a glide (approximant). Thus, we can safely conclude that the highlighted portion in (2) shows the duration of the glide segment from the fact that a sharp change of formants is observed in this portion.

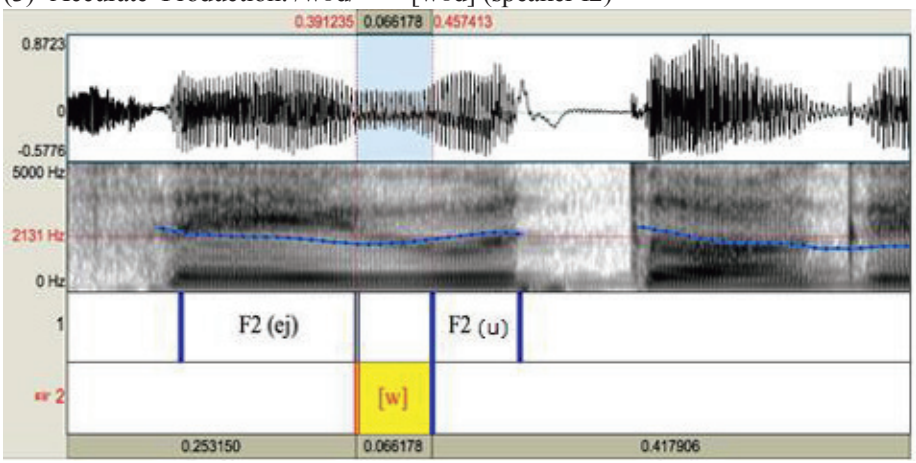
3. Discussion of the Results

After the examination of the data, it was found that the three speakers exhibited three different patters: i) 'accurate' production, in which there is a noticeable section of a homorganic glide, ii) deletion, in which the homorganic glide is deleted, and iii) glottalization, in which a glide is 'substituted by' a glottal stop. These results are discussed in detail in the following three sections.

3.1. 'Accurate' Production

Among the three participants, one speaker, f2, produced the sequence correctly; that is, there is a notable glide section observed in her production.

(3) 'Accurate' Production: /wʊd/ → [wʊd] (speaker f2)



In (3), the end point of the F2 of the preceding vowel and the start of the F2 of the following vowel are marked. The interval between these two points is taken to be the duration of the glide [w]. In (3), as we can see, there is an observable glide portion/duration; as discussed in (2), first, this portion exhibits a vowel-like formant structure. Furthermore, a sudden change in formant is observed in this portion. Thus, we can safely conclude that the highlighted portion of (3) is the glide [w]. What this means is that this speaker, f2, produced this sequence of interest accurately with a homorganic [+high, +back] glide directly preceding the vowel [ʊ].

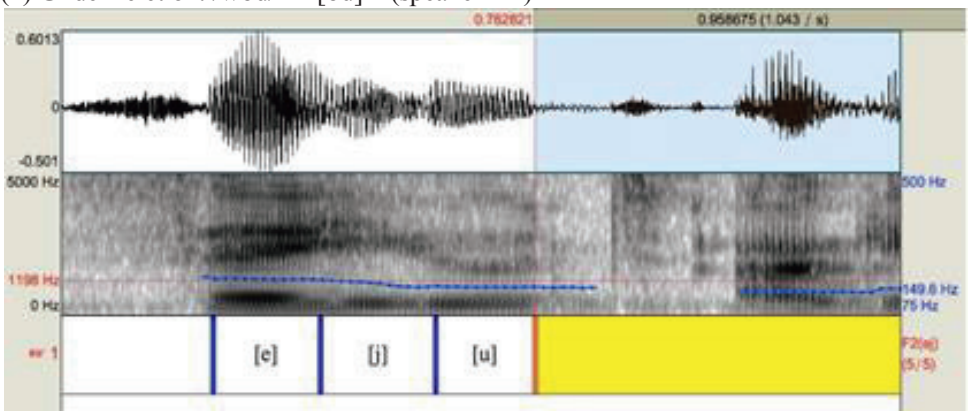
3.2. Glide Deletion

The remaining two speakers failed to produce this G-V sequence; as stated, this G-V[ho]

sequence, /w-ʊ/, is prohibited in Japanese, and if a Japanese speaker encounters this sequence, it is safe to assume that he or she will employ some kind of 'repair' strategy to avoid this sequence.

One of the repair strategies that was observed in the experiment is deletion, that is, to avoid a prohibited sequence in a speaker's native language, he or she deletes the preceding homorganic glide. This strategy is observed in m1.

(4) Glide Deletion: /wʊd/ → [ʊd] (speaker m1)



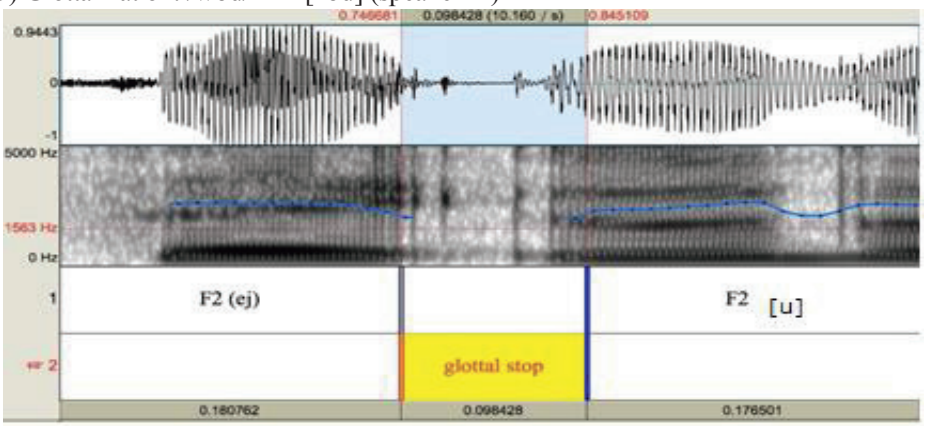
In (4), no glide segment can be identified; as indicated in (4), the vowel [ʊ] in 'wood' is directly preceded by the second half of the preceding diphthong, [ɪ] (in (4), the latter half of the diphthong is transcribed as [j], but this is only for typographical reasons). Unlike in the spectrogram presented in (3), no section of (4) exhibits a sharp or abrupt change in formants.

Based upon these observations, it is possible to conclude that in his production of English, this speaker, m1, deletes the homorganic glide [w] to avoid a sequence that is prohibited in Japanese. This fact leads us to conclude that one of the repair strategies for Japanese speakers to avoid the prohibited sequence is deletion; as seen in (3), the homorganic glide [w] is deleted to avoid the sequence [wʊ], which is possible in English, but not tolerated in Japanese.

3.3. Glottalization

As discussed, one possible strategy to avoid an unattested sequence is to deletion. However, deletion is not the only possible strategy; as can be seen in (5), changing one of the segments is another possible way to avoid a prohibited sequence. This is observed in speaker f1.

(5) Glottalization: /wʊd/ → [ʔʊd] (speaker f1)

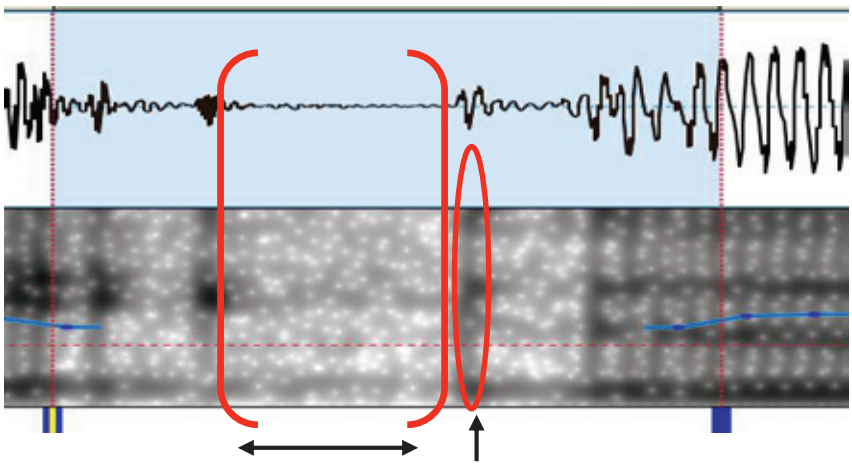


Unlike in (4), there is an interval between the start of the following vowel and the end of the preceding vowel in (5); this suggests that this speaker, f1, has 'something' between the two vowels. However, this 'something' cannot be the glide [w] because unlike in (3), no vowel-like formant structure is observed, nor do we observe any formant transition in (5). The question, then, is "What is this segment?"

Kang (2014) observes, in his study of Korean speakers, that native Korean speakers learning English employ 'glottalization' as one of the repair strategies to avoid a GV[ho] sequence; according to Sohn (1987, as cited in Kang 2014: 22), Korean exhibits rather strict phonotactic constraints for GV[ho] sequences as Japanese that are similar to that of Japanese, and it also prohibits the [w-ʊ] sequence. Kang (2014) reports that out of 299 G-V[ho] sequences he tested, there were 108 occurrences of glottalization, such as [wund] 'wound' pronounced as [ʔund], which means that glottalization is employed as a repair strategy in 43.8% of all of the occurrences of G-V[ho] sequences tested in his study.

According to Kang (2014), the acoustic properties of a glottal stop, or glottalization, can be summarized as follows: "absence of vibration followed by an abrupt, sharp, or sudden phonation onset (Ladefoged (1973), Gorden and Ladefoged (2001), Huber (1988), Dilley et al. (1996), Garellek (2013), as cited in Kang 2015: 104)." In (5), we observe the same, or at least, very similar,properties in the interval between the two vowels; first, the majority of this interval is produced without vocal fold vibration (no voicing bar in the spectrogram or no periodic waveforms are observed for the majority of this section). Then, suddenly, another phonation, namely voicing, starts in the latter section of the interval.

(6) Glottalization in f1's Speech



(a) No vocal fold vibration (b) Sudden/abrupt start of another phonation

The results of the measurement of f1's speech suggest that this speaker employs glottalization as a repair strategy; in (6), we can observe the acoustic properties of glottalization, and we can safely conclude that in her L2 production of English, this speaker replaces a glide with a glottal stop to avoid the sequence prohibited or unattested in her native language.

3.4. Summary of the Results

The speakers who participated in the experiment all exhibited three different patterns in the production of the GH[ho] segment unattested in their native language. As seen in (3), one speaker

accurately produced the /w-ʊ/ sequence without deleting or changing any segment. The other two speakers failed to produce this sequence, but the repair strategies were different.

One speaker, m1, employed deletion as a repair strategy; in this speaker's speech, the homorganic glide [w] is deleted, and /wʊd/ is pronounced as [ʊd]. The other speaker exhibited a different pattern, namely glottalization; in the speech of this speaker, /wʊd/ is pronounced as [ʔʊd]. This suggests that Japanese speakers employ glottalization as one of the repair strategies as Koreans do (use of glottalization as one of the repair strategies is reported in Kang (2014)).

Thus far in this article, the phonetic properties of the data have been examined. In the next section, I lay out preliminary phonological accounts of the data using the OT framework. I demonstrate that each speaker's interlanguage stage can be captured by ranking permutation of faithfulness constraints.

4. Phonological Account

4.1. The Interlanguage Hypothesis

Under the Interlanguage Hypothesis of second language acquisition (cf. Eckman 2015), L2 learners 'construct' their own grammar which contains both structures from their first language and the language that they are trying to acquire (referred to as the target language). According to Eckman (2015), speakers' interlanguage is independent both of their first language and of the target language. Under this hypothesis, foreign language learning can be defined as the acquisition of interlanguage, which gradually becomes close to the grammar of the target language.

When it comes to the phonologists' role in second language acquisition, one of the main tasks is to characterize the interlanguage grammar that each learner has acquired; more specifically, according to Eckman (2015), figuring out which properties of the learner's first (native) language constrain the acquisition of the properties of the target language is one of the major contributions that phonologists can make to the field of second language acquisition.

In this section, I present OT analyses characterizing the three production patterns observed in the experiment. I demonstrate that OT grammar captures both the constraining property in the speakers' native language and the 'repair strategy' that each speaker employs through constraint ranking and constraint ranking permutation.

4.2. OT Analysis 1: Grammar for English

As stated, one of the phonologists' major tasks in the field of second language acquisition is to figure out the constraining factor of the acquisition of a target language or a target structure. In OT terms, the (major) constraining factor can be represented by a high or undominated constraint. I propose that whether a speaker tolerates or avoids G-V[ho] sequences depends on the ranking of the constraint in (7).

(7) **DISTINCT GLIDE (DIST-G)** (Rubach 2002: 280)
The onset glide cannot be a copy of the nucleus.

The markedness constraint in (7) penalizes a G-V sequence in which an adjacent vowel and glide are homorganic; for example, the G-V sequence [w- ʊ] violates this markedness constraint because both the glide and the vowel are specified as [+high, +back]. In Japanese, this markedness constraint is active in the grammar (or in OT terms, it is high-ranked), while in a language like English, where the sequence homorganic glide and vowel is tolerated, this markedness constraint is low(er)-ranked.

In English, the /w-ʊ/ is pronounced or surfaces without any change, that is, no deletion or no segmental change. This suggests that the markedness constraint in (7) is dominated by the following faithfulness constraints.

(8) **MAX** (McCarthy and Prince 1995)
No deletion.

(9) **DEP** (McCarthy and Prince 1995)
No epenthesis.

(10) **IDENT [HIGH]** (Kang 2014: 159, cf. McCarthy and Prince 1995)
Output correspondents of an input [αhigh] segment are also [αhigh].

The faithfulness constraint in (10) mandates that if an input segment is specified as [+high], its output correspondent is also [+high], and thus, this faithfulness constraint guarantees that the [+high] feature of the glide /w/ in the input is maintained in its output correspondent.

The tableau in (11) shows the interaction of the constraints in (7) through (10). (11) shows that the ranking in which all of the faithfulness constraints in (8) through (10) dominate DIST-G results in the grammar of English, or the 'grammar' of f2, who maintains the [w-ʊ] sequence in the pronunciation (or in the surface form).

(11) /wʊd/ → [wʊd] (English / Speaker f2)

/w$_1$ʊd/	MAX	DEP	IDENT [HI]	DIST-G
☛a) w$_1$ʊd				*
b) ʊd	*!			
c) ʔ$_1$ʊd			*!	
d) ʔʊd	*(!)	*(!)		

In (11) and in the subsequent tableaux, subscript numbers indicate that input and output segments with the same number are in a correspondence relation; thus, in (11), the glottal stop in candidate (11c) is an output correspondent of the input glide. Hence, any change between an input glide and an output glottal stop incurs faithfulness violations. In (11d), on the other hand, no faithfulness relation can be established between the input glide and the glottal stop in the output, which is indicated by the lack of subscript number; faithfulness constraints are silent on any change between these two segments since these two are not in a correspondence relation.

In (11), four candidates are evaluated from an input, [wʊd]; (11a) is the fully-faithful candidate, where no segment change or deletion/epenthesis is observed. Candidate (11b) is a deletion candidate, in which the glide [w] is deleted. In (11c), the initial glide /w/ is changed into a glottal stop. Finally, in candidate (11d), which is phonetically identical to (11c), both deletion (/w/ is deleted) and epenthesis (glottal stop insertion) are observed.

In (11), both (11b) and (11d), where the input /w/ is deleted, violate MAX. (11d) also violates another faithfulness constraint, DEP since in this candidate, a glottal stop is epenthesized (after the glide [w] is deleted). Candidate (11c) satisfies both MAX and DEP, but this candidate violates another faithfulness constraint IDENT [HIGH]; as pointed out, the glide [w] is specified as [+high] while the glottal stop is specified as [-high]. Since [w] and [ʔ] are not identical in terms of height, candidate (11b) violates the height faithfulness constraint.

The tableau in (11) shows the following ranking argument:

MAX, DEP, ID [HIGH] >> DISTINCT GLIDE.

In English, there are no restrictions on the occurrence of G-V[ho] sequences; this is captured by the

low(er)-ranked DISTINCT GLIDE constraint. In languages like English, no change is observed in a homorganic G-V sequence; that is, no deletion or insertion, or no segment change is observed. In OT grammar, this fact can be captured by the ranking in which the faithfulness constraints MAX, DEP, and IDENT [HIGH] all dominate the markedness constraint that militates against G-V [ho] sequences.

Thus far, I have demonstrated how OT grammar captures the grammar of English, or the production of f2, in which the G-V [ho] sequence, /wʊd/, is realized faithfully (or is pronounced 'accurately'). In the next sections, I demonstrate how L2 production is explained through the ranking permutation of the constraints introduced thus far; in Section 4.3, the deletion case is discussed, and in Section 4.4, the case of glottalization is discussed.

4.3. OT Analysis 2: Deletion

One of the repair strategies to avoid the [w-ʊ] sequence is to delete the glide. In OT, this strategy can be captured with the low-ranked MAX constraint. This is illustrated in (12).

(12) /wʊd/ → [ʊd] (Deletion: Speaker m1)

/w$_1$ʊd/	DIST-G	DEP	IDENT [HI]	MAX
a) w$_1$ʊd	*!			
☛ b) ʊd				*
c) ʔ$_1$ʊd			*!	
d) ʔʊd		*!		*

In (12), candidate (12a) the fully-faithful candidate, loses because of the DISTINCT GLIDE constraint; this markedness constraint is violated by the sequence [w-ʊ] in which the two adjacent glide and vowel are homorganic. Candidate (12d) loses because of DEP, and (12c), in which the input /w/ is changed into a glottal stop, is excluded from the competition because of the height faithfulness constraint (candidate (12d) does not violate IDENT [HIGH] because the input /w/ and the output glottal stop are not in correspondence). As a result, (12b), the deletion candidate is selected as optimal.

(12) shows that a ranking in which DISTINCT GLIDE, DEP, and IDENT [HIGH] dominate MAX can capture the grammar of Speaker m1, which exhibits deletion of the glide; in other words, for this speaker, the markedness constraint against the [w-ʊ] sequence is active, and this markedness constraint is assumed to be the constraining property of his native language. The repair strategy of this speaker is expressed by the ranking, DEP, IDENT [HIGH] >> MAX, which selects deletion as a strategy rather than segment change.

As shown in (12), the constraints introduced in the previous section, when ranked differently, capture and characterize the grammar of deletion. The crucial difference between (11) and (12) is the ranking of MAX and DISTINCT GLIDE; in the English case, MAX is high(er)-ranked, and this faithfulness constraint guarantees that the input /w-ʊ/ surfaces faithfully. In (12), on the other hand, DISTINCT GLIDE is high-ranked, and this markedness constraint is assumed to 'hinder' the acquisition of the target sequence. Then, with MAX being low-ranked, deletion is selected as a strategy for repair.

4.4. OT Analysis 3: Glottalization

Finally, let us turn our attention to the third case, namely glottalization, which was exhibited in the speech of f1. As shown in (13), this pattern can also be accounted for by the constraints introduced thus far, but with a different ranking.

(13) /wʊd/ → [ʔʊd] (Glottalization: Speaker f1)

/w$_1$ʊd/	DIST-G	MAX	DEP	IDENT [HI]
a) w$_1$ʊd	*!			
b) ʊd		*!		
☛c) ʔ$_1$ʊd				*
d) ʔʊd		*(!)	*(!)	

(13) shows that the ranking DISTINCT GLIDE, MAX >> IDENT [HIGH] captures the grammar of glottalization; as in (12), the high-ranked markedness constraint DISTINCT GLIDE is the driving force of the change, or in terms of SLA, this constraint is the property of her native language that constrains the acquisition of the target structure. Unlike in (12), MAX dominates the faithfulness constraint IDENT [HIGH], and this ranking prefers segment change, rather than segment deletion, as a repair strategy. Thus, (13) shows that the markedness and faithfulness constraints introduced thus far successfully capture the grammar of glottalization.

One might ask, however, "Why is the glottal stop preferred?" In other words, why is the glottal stop preferred as a 'replacement' of /w/, rather than other segments? This problem is illustrated in (14).

(14) "*Why Japanese People*?! Why [ʔ]? Why not [t]?"

/w$_1$ʊd/	DIST-G	MAX	DEP	IDENT [HI]
a) w$_1$ʊd	*!			
b) ʊd		*!		
c) ʔ$_1$ʊd				*
d) t$_1$ʊd				*

In (14), none of the candidates are selected as optimal; (14a) and (14b) are excluded by DISTINCT GLIDE and MAX respectively. The remaining two candidates, (14c) and (14d), tie under DEP. The low(er)-ranked IDENT [HIGH] fails to resolve the tie since both of these candidates equally violate this faithfulness constraint ([t] is also specified as [-high]).

What, then, is the motivation for having a glottal stop, rather than other segments such as [t] in this position? Following Kang's (2014) proposal, I suggest that syllable well-formedness is the key to the solution. If we look at the 'position' of the glottal stop or [t] in these candidates, we observe that it is in an onset position. In terms of 'syllable well-formedness,' an ideal syllable onset shows greater sonority raise; that is, the greater the distance between an onset segment and a syllable nucleus (which, normally, is a vowel) in the sonority scale, the more ideal as a syllable. In this sense, laryngeal consonants are better than, for example, [+coronal] segments like [t] (cf. Prince and Smolensky 1993) because laryngeal consonants are less sonorous than [+coronal] segments. Following Kang (2014), I assume the following two 'syllable margin' constraints to solve this problem.

(15) ***MARGIN/OBS (*M/OBS)** (Kang 2014: 162)
[-sonorant] segments are not in a syllable margin.

(16) ***MARGIN/LAR (*M/LAR)** (Kang 2014: 162)
Laryngeal segments are not in a syllable margin.

To capture the fact that laryngeal consonants are preferred segments for syllable margins, the ranking, *M/OBS >> *M/LAR, is assumed. This analysis is presented in (17).

(17) Problem Solved: /wʊd/ → [ʔʊd]

/w$_1$ʊd/	DIST-G	MAX	*M/OBS	*M/LAR	ID [HI]
a) w$_1$ʊd	*!				
b) ʊd		*!			
☛c) ʔ$_1$ʊd				*	*
d) t$_1$ʊd			*!		*

In (17), candidate (17c) with a glottal stop is selected as optimal; candidates (17c) and (17d) tie under the height faithfulness constraint, and the competition goes down to the syllable-margin constraints. As a result, the competing candidate (17d) loses because of the syllable-margin constraint. (17) shows the following ranking argument.

As seen in (18), the ranking, *M/OBS >> IDENT [HIGH], needs to be established; in (18), the competing candidate (18d) contains a [k], which is specified as [+high].

(18) Another Competitor with a [k]: /wʊd/ → [ʔʊd]

/w$_1$ʊd/	DIST-G	MAX	*M/OBS	*M/LAR	ID [HI]
a) w$_1$ʊd	*!				
b) ʊd		*!			
☛c) ʔ$_1$ʊd				*	*
d) k$_1$ʊd			*!		

In (19), candidate (19d), which contains a [+high] segment as an output correspondent of /w/, loses because of the syllable-margin markedness constraint. The actual form with a glottal stop (candidate (19c)) performs worse than (19d) under the faithfulness constraint for height. Thus, (19) shows that the syllable-margin markedness constraint needs to dominate the height faithfulness constraint to select an actual candidate with a glottal stop over a form with a [+high] segment. (19) shows the summary of the ranking for glottalization:

(19) Ranking Argument for Glottalization

DIST-G, MAX, >> DEP, *M/OBS >> *M/LAR>> IDENT [HIGH]

To achieve the glottalization pattern, it is crucial to establish a ranking in which IDENT [HIGH] is dominated by DISTINCT-GLIDE, MAX, and *M/OBS. It is also necessary to establish the ranking between the syllable-margin constraints and the height faithfulness constraint, so that a candidate with a glottal stop in the onset is selected as optimal.

5. Discussion and Final Remark

5.1. Summary

Thus far, I have presented preliminary phonological analyses of the data; (20) summarizes the ranking permutation of the constraints used to account for the three patterns observed in the experiment.

(20) Ranking Permutations (with DISTINCT-GLIDE, MAX, and IDENT [HIGH])

a) MAX, IDENT [HIGH] >> DISTINCT-GLIDE

b) DISTINCT-GLIDE, IDENT [HIGH] >> MAX

c) DISTINCT-GLIDE, MAX, >> IDENT [HIGH]

The ranking in (20a) is for English, or 'accurate' pronunciation in which the G-V[ho] sequence surfaces or is pronounced faithfully. (20b) is the ranking for glide deletion, where deletion of the glide is employed as a repair strategy, to avoid G-V[ho] sequences. (20c) is the raking for glottalization, in which the underlying /w/ is changed into a glottal stop.

In terms of the Interlanguage Hypothesis, this can be interpreted as follows; speaker f2, who tolerates the G-V[ho] sequence, has acquired the grammar in (20a), which native English speakers acquire when they acquire English; speakers m1 and f1 acquired the grammar in (20b) and (20c) respectively; in both (20b) and (20c), DISTINCT-GLIDE is a dominating constraint, and this suggests that this phonotactic constraint banning homorganic glide-vowel sequence (which is active in the grammar of the speakers' native language) is the constraining factor on acquisition. Even though the constraining factor is the same, the 'repair strategy' is different between f1 and m1; this is illustrated by the different rankings of the constraints MAX and IDENT [HIGH]; in other words, we can conclude that these speakers' interlanguage can be categorized by the different rankings of these two constraints.

5.2. Discussion

Thus far, the data have been analyzed 'neatly' and all three attested cases have been explained successfully in the OT framework. However, there are several issues to be discussed in connection to this preliminary study.

The major problem with the study presented in this article is, of course, the paucity of the data; the data used in this article have been collected only from three speakers. One obvious problem is that there may be other strategies for repair that did not appear in such a small amount of data. For example, Kang (2014) reports vowel or glide shift as another possible strategy observed among Korean speakers; according to Kang, some native speakers of Korean, in producing the English [w-u] sequence, change /w/ to [j] to avoid this homorganic sequence. Likewise, some speakers shift the vowel /i/ to [ə] to avoid the sequence [ji], in which homorganic [+high, -back] segments occur adjacently. In the data that I have collected thus far, no cases of glide or vowel shift have been attested, but this does not mean that Japanese speakers will not employ glide/vowel shift as a repair strategy. More data are necessary to fully investigate possible repair strategies to avoid V-G[ho] sequences among native Japanese speakers.

More data collection is necessary to investigate theoretical aspects as well; as seen in (19), if we assume free-ranking of three constraints, we can successfully account for the attested three patterns. However, this assumption, in theory, predicts that the three different patterns should be observed with the same frequency. To consider this theoretical question, let us look at the more detailed ranking permutation presented in (20):

(20) *Detailed* Investigation of the Ranking Permutation

A) MAX >> IDENT [HIGH] >> DISTINCT-GLIDE **NO CHANGE**
B) MAX >> DISTINCT-GLIDE >> IDENT [HIGH] **GLOTTALIZATION**
C) DISTINCT-GLIDE >> IDENT [HIGH] >> MAX **DELETION**
D) DISTINCT-GLIDE >> MAX >> IDENT [HIGH] **GLOTTALIZATION**

E) IDENT [HIGH] >> MAX >> DISTINCT-GLIDE **NO CHANGE**
F) IDENT [HIGH] >> DISTINCT-GLIDE >> MAX **DELETION**

With three (3) constraints, six (6 = 3!) different rankings can be obtained; as seen in (20), with the permutation of these constraints, equal occurrence of the three patterns is predicted. In theory, this prediction should match the *actual* occurrence among speakers; for example, if 100 speakers are tested, roughly speaking, each of these patterns should be equally observed in 33 speakers. It goes without saying that we need to collect data from more speakers to test this hypothesis; in order to prove the 'validity' of this analysis, or more specifically, to be able to claim that these three constraints are free-ranked, we need more data to quantitatively show these three patterns are equally observed.

Finally, as stated, there may be additional repair patterns for avoiding the prohibited sequence. Besides investigating additional strategies, we also need to make sure that these three patterns, or two repair patterns, are consistently observed among speakers. In other words, it is necessary to prove that the patterns that have been discussed in this article are not just observed haphazardly. In order to do so, again, we need to collect more data: not just data with /w/ or the sequence of /wu/ but also another logically-possible homorganic G-V sequence, /ji/, which is also prohibited in Japanese.

5.3. Final Remarks

It is true that the data collected and analyzed in this article are not yet sufficient for a full phonological analysis. It is also true that the phonological analysis of the data is still preliminary, and there are other theoretical aspects that need to be further investigated. Nonetheless, some interesting facts about L2 English production by Japanese speakers have been revealed. One of the interesting issues is the fact that glottalization is employed as one of the repair strategies by one of the Japanese speakers. As stated in Kang (2014), in Korean speakers' production of English, glottalization is commonly observed; in more than 40% of the occurrences of homorganic G-V sequences in Kang's study are repaired by glottalization. As stated, it is necessary to quantitatively investigate the occurrence of glottalization among Japanese speakers, but the exploration of the similarities and differences between Korean and Japanese speakers in terms of repair is also one of the interesting topics that can be further studied in the future research.

In this article, only the G-V[ho] sequence with /w/ is tested, but there is another glide in Japanese, namely, the palatal glide /j/, and to fully lay out the phonological analysis, data with /j/ also need to be collected and investigated. One of the questions that can be investigated with the /j/ data is whether the same repair strategies (which are employed in avoiding the /w-u/ sequence) are attested to avoid the sequence /j-i/.

Finally, two repair strategies are reported in this article, and this finding leads to the question, "Are repair strategies correlated to the speakers' level of proficiency or exposure to English?" In other words, does a learner employ a different repair method as her or his proficiency level goes up, or do learners choose the strategy randomly? Once again, more data collection and more phonological investigation are necessary to present full and complete phonetic and phonological analyses. Nonetheless, the study presented in this paper provides a promising start to a bigger study.

Notes

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